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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XXVII.

THE HOUSTON BLACK CLAY.

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THE HOUSTON BLACK CLAY.

GEOGRAPHICAL DISTRIBUTION.

The Houston black clay is the most widespread and important of the soils found in the Black and Grand Prairie sections of southern Oklahoma and of central Texas. Its occurrence, so far as it has been encountered in the soil surveys, is almost entirely confined to this region, although small areas undoubtedly exist in the Cretaceous prairie region of central Alabama and northeastern Mississippi. It is within the great prairie region of Texas that this type is principally to be found. The Houston black clay has been encountered in 15 different soil survey areas located in Alabama, Oklahoma, and Texas and mapped to a total extent of 1,402,392 acres. The region formed by the Black and Fort Worth Prairies includes far greater areas of the Houston black clay than those already mapped. It is safe to estimate that in southern Oklahoma and in central Texas, together with several areas in other States, there will ultimately be found over 15,000,000 acres of this important soil type.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The surface soil of the Houston black clay is a drab, dark-brown or jet-black clay, having an average depth of about 10 inches. The soil is friable when well cultivated and in a condition of moderate moisture, but it is exceedingly waxy and sticky when wet, and in this condition its structure may be seriously injured if it is plowed or otherwise tilled. The waxy nature of both the surface soil and subsoil of this type has given rise to the popular name of "Black Waxy Prairie" for the section where it is prevalent. The subsoil is a drab, light-brown, or sometimes blue or gray, tenacious clay which is very waxy and stiff. It extends to a depth usually exceeding 3 feet, but may be underlain at about this depth by the gray or chalky marl of the Austin chalk and Taylor marl formations. In Alabama and in Mississippi the soil is derived chiefly from the Selma chalk.

Although the surface soil and subsoil of the Houston black clay are exceedingly waxy and tenacious when wet, the surface soil has the property of cross-checking into innumerable fine granular aggregations of clay when it is partly dried. If plowed or otherwise tilled

when the moisture condition is exactly right, this granulation is promoted and an excellent surface tilth may be secured.

The Houston black clay is easily distinguishable from all other upland soils within the Coastal Plain region. Its distinctive black coloration, its waxy nature, and its obvious derivation from the underlying white, gray, or blue marl are all characteristic of this type. It is the only extensive black clay soil of the upland region.

SURFACE FEATURES AND DRAINAGE.

Characteristically the Houston black clay occupies the nearly level or gently undulating prairies of southern Oklahoma and central Texas. These regions have a distinct relief when viewed broadly. Any single square mile of the prairie country is almost absolutely level, or only gently sloping, but when an area the size of a county is considered, it will be found to consist of broad gently sloping ridges separated by shallow nearly level hollows or slightly sloping valleys. There are no pronounced elevations and no steep slopes within the area of these prairies. The major streams, which flow from the inland region to the seacoast, have frequently cut broad, rather shallow trenches through the surface of the land, along whose margins erosion has in places cut back gullies to a distance of several miles. It is within such areas that the chief topographic breaks within the surface of the prairie occur, and where the principal danger from erosion is encountered in the cultivation of the type.

The Houston black clay is fairly well drained in all of the areas where it occurs. Only the more level tracts occupying the depressions between the higher ridges are found lacking in this respect. The subsoil drainage is not always so good. The stiff, waxy plastic subsoil retains large amounts of soil moisture, and as a result, upon the most level areas it is frequently the case that the natural internal drainage of this type should be supplemented by the installation of tile drainage systems. This applies particularly to those portions of the type which lie in the more humid region of its occurrence.

Erosion is not a serious feature in the cultivation of the Houston black clay, with the exception of limited areas where the main upland portion of the type is intersected by the major streams or their tributaries. In such localities, to a limited extent, erosion along the steeply sloping stream banks and smaller gullies is sometimes serious upon the individual farm, although nearly negligible so far as the entire extent of the type is concerned.

LIMITATIONS IN USE.

The Houston black clay is probably the stiffest and most tenacious upland soil among those generally used for agricultural purposes in the Gulf States. Its texture and even its characteristic structure are such

that special crops, particularly vegetables and the other market-garden products, are not at all well suited to production upon the type. These crops may only be raised to advantage locally and in small areas for home use or for the supply of some city in the immediate neighborhood.

The same characteristics of texture and of structure render the Houston black clay one of the strongest and most fertile of the general farming soils to be found in the Gulf Coastal Plain. In the various areas where it occurs corn, cotton, oats, wheat, and various forage crops are all produced to excellent advantage wherever the rainfall is sufficient to bring them to maturity.

The type has never been found suitable for the production of the tree fruits, either apples or peaches, owing undoubtedly to the stiff, waxy nature of the soil itself and to the presence of an extremely stiff clay subsoil near the surface.

IMPROVEMENT IN SOIL EFFICIENCY.

In the majority of areas where it occurs the Houston black clay has been cultivated continuously for a period ranging from 25 to 50 years to a few crops, chief among which is cotton. In spite of the wonderful natural fertility of the soil this continued one-crop production has led to diminished yields. As a result, one of the first essentials for improvement in the efficiency of this soil consists in the adoption of a crop rotation suited to the climatic conditions and to soil characteristics of the Houston black clay under its dominant surroundings.

In the more humid sections where the type is found, in east-central and northeastern Texas and in southern Oklahoma, it is probable that cotton should remain the dominant money crop. It is not desirable, however, that this crop should be produced to the exclusion of all others or in such acreage quantity as to prevent a systematic crop rotation upon the farms. Following the cotton crop in any year it is preferable that a crop of winter oats should be sown upon the soil, to be grazed off during the winter or turned under as a green-manuring crop in the succeeding spring. At this time corn should be planted upon the same acreage, and with the last cultivation in the fall cowpeas, crimson clover, or some other leguminous crop should be seeded in between the rows to make a fall and winter growth upon the area. Where the acreage under cultivation would justify it this crop may be followed by a summer crop of cowpeas raised for forage or hay. It would then be possible in the succeeding year to return to the cultivation of cotton.

Local conditions of climate, markets, and possibilities of adjusting the rotation to the fields of the individual farm or plantation will necessarily modify the rotation which might be adopted in any particular locality. Winter wheat can also be grown upon the more

northern areas of the type, and it is desirable to raise alfalfa upon at least some portion of the farm acreage in addition to the crops mentioned, which may be arranged in regular rotation. Alfalfa thrives upon the well-drained areas of the type and should be more extensively grown.

In the western and southwestern areas it is found desirable to produce more drought-resistant crops than are planted in the localities where rainfall is more abundant. For these former locations sorghum, millet, kafir, and alfalfa are all available, either in conjunction with cotton or in areas where the latter crop is not extensively produced.

For the improvement of the efficiency of the Houston black clay it is also desirable that greater attention should be paid to the internal drainage of the subsoil. While the greater portion of the type is well drained, so far as the surface flow of water is concerned, the stiff, waxy claylike nature of both surface soil and subsoil tends to store a large amount of excess moisture in the subsoil and also to render the surface soil plastic and sticky until late in the spring planting season. Tile underdrainage to promote the downward percolation and removal of water absorbed by the soil should be installed over many thousands of acres of this type. Such an improvement, while of considerable initial cost, is usually amply repaid through the fact that the land may be tilled at an earlier date, that it may be cultivated more immediately after a rainfall, and that the available water supply of both surface soil and subsoil throughout the growing season is more easily obtained by the growing crops. Tile underdrainage is essential for the production of alfalfa on all of those areas of the type whose surfaces are practically flat.

To the present time nearly all areas of the Houston black clay have been tilled regardless of the fertilization of the soil, either through the restoration of organic matter to the surface soil or the application of mineral commercial fertilizers. While either class of fertilization is possibly less needed upon the Houston black clay than upon the majority of other southern soils, still the structure of this waxy clay may be greatly improved by the incorporation of organic matter as frequently as may be possible in the crop rotation. The fibrous nature of the green crop plowed under aids in the granulation and the improvement of the texture of the surface soil. In this connection lime should be applied at the time when the green crop is plowed under, in order to promote its decomposition and incorporation with the soil.

So little has been done in the line of the application of commercial fertilizers to the Houston black clay that little may be said in regard to the proper use of these materials. Further experimentation should be conducted along this line.

LIMITATIONS UPON SPECIAL CROPS.

The characteristic waxy texture of the surface soil of the Houston black clay in itself limits the special crops which may be grown upon the type. In general, only those vegetables which are needed for the supply of the farmer's table, or which find a ready market in nearby towns, should be grown to any extent upon this soil. Attempts at the production of onions upon the Houston black clay have been fairly successful. Areas where the surface soil is somewhat sandy, or where it is particularly well granulated and thus made friable, should be selected for the production of this crop. The drainage, both over the surface and through the subsoil, must be carefully attended to before any vegetable or special crops may be grown.

The tree fruits are not particularly well suited to the Houston black clay. However, it is well in all circumstances for the individual farmer to attempt the growth of his own home supply of apples, peaches, and cherries, even though only a few trees of each variety be planted. The prairie country does not appear well suited to the production of the tree fruits upon a commercial scale.

EXTENT OF OCCUPATION.

Throughout the more humid portion of the region dominated by the Houston black clay, and particularly in northern Texas and southern Oklahoma, practically all of this type is occupied for agricultural purposes. In the majority of soil survey areas where the type has been encountered it is reported as "one of the most productive soils in the area," or as "the most valuable soil in the county for the staple crops." In other areas it is reported as "entirely under cultivation, and the strongest soil of the area." This local reputation of the Houston black clay in the various areas where it has been encountered is borne out by a study of the crop production and of the agricultural prosperity of the regions where the type occurs. Many of the most important and thriving cities of Texas are located either within or adjacent to areas occupied and dominated by the type. They constitute the great agricultural centers of this prairie region where products are gathered for shipment to distant markets and from which the supply of farm machinery and other commodities demanded by the farmer are distributed.

The statistics showing the distribution of the yields of cotton per square mile clearly outline the region within which the Houston black clay is principally developed. Within the area dominated by this soil type the yields per square mile exceeded 50 bales in the census of 1900. Only the alluvial lands of the Mississippi bottoms equaled this production. The superiority of the type as a cotton-producing soil and its high value for the production of corn, wheat, sorghum,

and alfalfa, under favorable climatic conditions, have made it highly prized as farming land and led to its almost complete occupation. This does not mean that all of the areas of the Houston black clay are given up equally to the intensive production of the great staple crops, but it does mean that the bulk of this type has passed chiefly into private ownership and must now be purchased from individual owners by those still desiring to develop land of this kind for the production of either staple or special crops. It is only in those extreme southwestern regions where rainfall is scarcely sufficient under normal conditions to produce the great staple crops that the areas of the Houston black clay are now only partially occupied or used for grazing.

It is probable that within the humid region where the type occurs fully 90 per cent of the entire area is occupied for the production of some farm commodity. Within the semiarid region probably not over 5 per cent of the type is occupied for crop production, and the remainder used chiefly for grazing purposes.

The price at which land of this type may be purchased depends largely upon the attendant rainfall conditions, distance from main lines of transportation, and upon the character of the improvements which have been placed upon the land. In those localities most unfavorably located with regard to all of these factors areas of the type may still be bought at $10 to $15 per acre, but within other areas more favorably located the price of this land ranges from $50 to $150 per acre. This variation in price is due largely to attendant circumstances and not to the quality and fertility of the soil itself. It may be considered one of the most valuable, if not the most valuable, of the widely distributed cotton soils of the central and western Gulf States.

While all of the Houston black clay is probably occupied for some agricultural purposes, not all of the type is occupied for either intensive or diversified agriculture. There remains a decided opportunity for a higher degree of development of the lands already held in private ownership, even though no additional acreage of this soil may be brought into cultivation.

CROP ADAPTATIONS.

The Houston black clay is the great prairie cotton soil of the western Gulf States. This soil probably produces more bales of Upland cotton than any other single soil type in the United States. Not only is this true, but also larger average yields per acre are produced upon this type through a longer period of time than upon any other Upland cotton soil. Cotton is almost universally grown upon the Houston black clay wherever the annual precipitation is sufficient to mature the crop. The yields have been given in a large number

of soil-survey reports, varying from one-half to three-fourths of a bale per acre. In many instances they are reported at from one-half to one bale per acre, and there are numerous recorded cases where they have been in excess of one bale. Many of these reports were made before the advent of the cotton-boll weevil, and it is possible that at the present time some reduction in the yield per acre should be made because of the damage caused by this pest.

The Houston black clay is a soil which retains sufficient moisture to make a good to large growth of plant and matures the cotton at rather a late date during the growing season. Some difficulty has been encountered in combating the boll weevil upon this soil type. However, through the selection of the proper strains and varieties of cotton for growth upon the "black waxy land" this difficulty has been largely overcome, and it is probable that within the next few years the Houston black clay may again be reported as producing an average cotton yield in excess of one-half bale per acre and possibly approaching the three-fourths bale mark frequently reported in previous years.

Next to cotton, corn is probably the principal crop grown upon the Houston black clay, although the acreage devoted to this crop is only a small fraction of that devoted to cotton growing each year. However the yields are very satisfactory. In the numerous areas from which reports have been received through the Soil Survey, corn has been reported as yielding from 25 to 40 bushels per acre, with average yields ranging from 40 to 50 bushels frequently reported. Doubtless when proper attention is paid to the preparation of the land and to the subsequent tillage of the crop, the Houston black clay may be depended upon to produce upwards of 40 bushels per acre. This is far above the average yields for the States within which the type occurs. Aside from the smaller areas of bottom land along the principal streams, it is probable that no other southern soil, developed upon a large scale, can equal the Houston black clay as a corn soil. The acreage devoted to corn each year is being steadily increased

In the northern portion of the region where this type is developed, winter wheat has also been extensively grown in years past. The acreage devoted to this crop shows a decline within the past decade and the crop is no longer an important one upon this soil. Winter oats are also grown to a limited extent, the yields ranging from 30 to 40 bushels per acre upon the best lands seeded to this crop.

Within recent years the adaptation of the Houston black clay to alfalfa growing has come to be appreciated in the more northern regions where the type occurs. This soil possesses several of the characteristics requisite for growing this crop, being highly calcareous in both surface soil and subsoil, the deeper portion of the latter being frequently underlain by more calcareous marl or chalk formation, and being furthermore a soil of moderate to high fertility.

The one serious drawback to the successful production of this crop lies in the stiff, waxy nature of the type, which sometimes interferes with bringing the surface soil to that degree of looseness and friability necessary for the best results with alfalfa or other grass crops.

This may be done through the use of disk machinery, and the thorough preparation of the soil and its subsequent tillage under the proper moisture conditions. Well-established fields of alfalfa upon this type produce three to four crops a year, averaging about 1 ton of hay for each cutting. This brings alfalfa, produced with a minimum of hand labor, into direct competition with cotton as a money crop. There is always a demand for good alfalfa hay in the cotton-producing section dominated by the Houston black clay and this crop is coming to be a specialty with some of the most progressive farmers and planters.

Upon some limited areas of the Houston black clay Johnson grass has obtained a strong hold, such land being considered less desirable by the average cotton planter than the other portions of the type. For a long time this grass was considered merely as a pest. It has been found, however, to have a high feeding value and the Houston black clay produces from 2 to 3½ and even 4 tons of Johnson-grass hay in a single year. Areas covered with this grass now show only a comparative loss, since the profit from it is usually somewhat less than from a well-tended cotton field.

Alfalfa has frequently been seeded into areas covered by Johnson grass, the mixed hay thus produced having a considerable value and constituting nearly a balanced ration. The earliest cut of the mixed hay will consist chiefly of alfalfa, the second cut of an almost equal mixture of the two, while a later cut will be almost clear Johnson-grass hay. Thus the forage resources of the plantation may be considerably increased through the utilization of areas infested by Johnson grass for the production either of that hay or of the mixed hay just described. Directions for the eradication of Johnson grass may be obtained by writing to the United States Department of Agriculture.[1]

In areas where the rainfall is less ample, particularly in the extreme southwestern part of Texas, the production of sorghum has been undertaken and yields of 2 to 3 tons per acre secured. The crop makes excellent forage. Melilotus usually grows wild and is used for grazing purposes. In these regions the wild grasses are used for grazing, and some small areas are cut for wild-grass hay, giving yields of one-half to three-fourths ton per acre. Kafir, milo maize, and the millets are also well suited to these regions of smaller rainfall.

With the forage crops enumerated above it would be perfectly feasible, as well as desirable, to establish a more intensive form of

[1] Farmers' Bulletin No. 279, Methods of Eradicating Johnson Grass.

animal husbandry upon the Houston black clay than has yet been attempted outside of a few restricted localities. The type is an admirable corn soil. It is well suited to the growing of alfalfa, the sorghums, Johnson grass, and millet, while even cowpeas and other legumes thrive upon it. As a result, under the favorable climatic conditions existing over the greater part of the area occupied by this soil the production of beef animals, not upon the wild-hay pasture, but upon carefully tended crops should be profitable. Some attempts have been made at hog raising upon an extensive scale. These have usually been decidedly successful. In the majority of instances a few hogs are kept on plantations or farms. However, an opportunity exists for the extension of this form of animal industry for the consumption of the corn and alfalfa which may be raised upon the farm. Exclusive hog farming may or may not be profitable under different conditions, but in connection with the production of the alfalfa crop and with corn to supplement the acreage devoted to it, hog raising should constitute a very profitable side line.

Wherever the demand for dairy products is sufficient to warrant it, corn and alfalfa, millet, sorghum and Johnson grass, may all be used to good advantage in feeding dairy cattle.

Thus there is an admirable opportunity on the Houston black clay for a much greater diversification of the present agricultural occupation and for the more profitable use of the many extensively farmed areas of the type.

FARM EQUIPMENT.

The farm equipment upon the Houston black clay varies considerably upon the different areas where it has been encountered. In the more western areas which have only been occupied for a short period of time, the farm buildings and equipment are sometimes primitive. On the other hand, the greater part of the Black and Grand Prairie country has been occupied agriculturally for periods ranging from 35 to 50 years. Here the farm buildings are well constructed, well planned for the purposes of the plantation or the farm, and the equipment of fences, work stock, and tools is of a high character. There are many variations in the equipment, depending upon the taste and the ability of the owner of the individual property. In general the farmhouse, the shed for the work stock, the windmill, and the feeding yard are the normal improvements to be found upon the farms occupying this type.

In the majority of cases the work stock employed in the tillage of the Houston black clay consists of medium to heavy weight mules, used in the 2 and 4 mule hitch. The use of this heavier stock and of the larger number of farm animals is imperative upon this type, owing to its waxy, plastic nature, and to the difficulty experienced

in plowing it, either with lightweight work stock or lightweight tools. Within later years the introduction of disk machinery has greatly facilitated both the plowing and subsequent tillage of this type. The disk machinery is not so liable to become clogged by the stiff, waxy clay as the old mold-board form of plow or cultivator.

SUMMARY.

The Houston black clay is one of the most important of the upland soils in the western Gulf States. It occupies the "black waxy" prairie region of southern Oklahoma and central and southwestern Texas. Small areas are also found in Alabama.

The surface of the Houston black clay is prevalently broadly rolling to undulating, with no very steep slopes and with limited areas of absolutely level land lying between the ridges or undulations. The surface drainage is usually good, only the more level areas suffering in this respect.

Erosion is not a serious problem except along the margins of streams which cut across the formation from which it is derived, and along their principal tributaries. Such areas occupy only a small percentage of the total extent of the type.

The Houston black clay, because of its physical characteristics and its surface configuration, together with its climatic location, is best suited to the production of the great staple crops of the Gulf region. Special crops are not grown to any extent upon the type. It is probably the best and most productive of the extensive Upland cotton soils of the Southern States. Throughout large areas the average yield of cotton upon this type is reported at one-half to three quarters of a bale per acre, and in many individual instances it exceeds 1 bale per acre.

The Houston black clay is also an excellent corn soil, although a smaller acreage is devoted to this crop than to cotton. The yields range from 25 to 50 bushels per acre, with a general average of about 40 bushels.

Winter wheat is grown to a limited extent in the more northern regions occupied by this soil, and winter oats throughout the area where it occurs.

More recently alfalfa has been grown upon the Houston black clay, and the better drained areas of the type are well suited to this crop. It yields from 3 to 4 tons per acre under favorable conditions.

Johnson grass has been cut for hay over restricted areas of this soil, the yields ranging from 2½ to 4 tons per acre.

Under conditions of less rainfall, sorghum, millet, kafir, milo maize, and other semiarid-land crops are grown to advantage. Wild grass is cut in the extreme western portions of the area, giving

yields of one-half to three-quarters of a ton per acre, while extensive areas are annually grazed for the fattening of cattle.

Practically all of the areas of the Houston black clay have been occupied for some form of agricultural production. Where the rainfall is abundant, nearly every acre of the type is held at a high price for the production of cotton, corn, and forage crops. With less rainfall large tracts of the Houston black clay have been occupied for grazing purposes. Thus the development of the type must take the form of more intensive agriculture upon lands already occupied rather than the occupation of additional acreage.

The Houston black clay is ordinarily well improved by substantial dwelling houses and outbuildings. It is tilled through the use of the heavier work stock and the two or four mule hitch. It has been found that disk machinery, whether plow or cultivator, is better capable of handling this waxy soil than the ordinary mold-board form of tillage machinery.

The Houston black clay constitutes one of the most important general farming soils of the western Gulf coast region.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *October 30, 1911.*

APPENDIX.

The following table shows the extent of the Houston black clay in the areas surveyed to this time. In the first column is stated the particular survey in which the soil was encountered; in the second column its extent in acres; and in the third column the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of the Houston black clay encountered in the soil survey.

Survey.	Area of soil.	Date.[1]
Alabama:	*Acres.*	
Sumter County	26,648	1904
Oklahoma:		
Tishomingo area	75,392	1906
Texas:		
Anderson County [2]	3,264	1904
Austin area	183,936	1904
Bastrop County	16,128	1907
Cooper area	166,272	1907
Grayson County	137,088	1909
Houston County	3,200	1905
Lavaca County	215,232	1905
Lee County	38,208	1905
Paris area	35,008	1903
San Antonio area	22,976	1904
San Marcos area	128,704	1906
Waco area	57,280	1905
Willis area [3]	20,480	1901

[1] Year of publication, Field Operations.
[2] Mapped as Houston clay.
[3] Mapped as San Jacinto clay.